PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G01V 3/18, E21B 49/08, 47/00, 47/10, 49/00

A1

(11) International Publication Number: WO 00/43812

(43) International Publication Date: 27 July 2000 (27.07.00)

(21) International Application Number: PCT/US00/01951

(22) International Filing Date: 26 January 2000 (26.01.00)

(30) Priority Data:
09/236,993 26 January 1999 (26.01.99) US

(71) Applicant: HALLIBURTON ENERGY SERVICES, INC. [US/US]; 4100 Clinton Drive, Building 01, 6th Floor, Houston, TX 77020 (US).

(72) Inventors: GARNDER, Clarence, G.; 1919 Mistyvale Court, Richmond, TX 77469 (US). HRAMETZ, Andrew, A.; 806 Magnolia Drive, Rosenberg, TX 77471 (US). WAID, Margaret, C.; 3103 Hollow Creek Court, Houston, TX 77082 (US). PROETT, Mark, A.; 3611 Covey Trail, Missouri City, TX 77459 (US).

(74) Agents: CONLEY, ROSE & TAYON, P.C. et al.; P.O. Box 3267, Houston, TX 77253-3267 (US).

(81) Designated States: NO, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

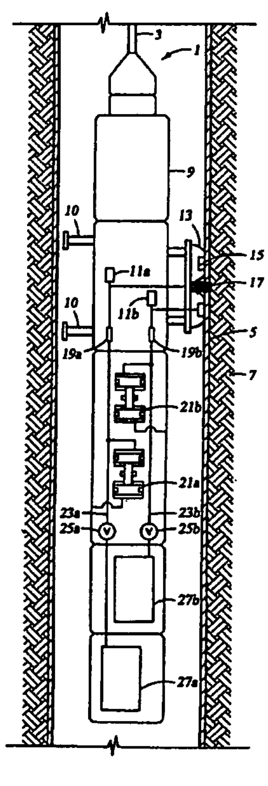
Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: FOCUSED FORMATION FLUID SAMPLING PROBE

(57) Abstract

A formation fluid sampling probe uses two hydraulic flow lines (23a, 23b) to recover formation fluids from both a guard zone and probe zone in a borehole (1) passing thru earth/rock formation (7). The guard zone surrounds the probe zone, thus shielding it from any direct access to borehole fluids. Operation of the tool involves withdrawal of fluid from both zones into a probe sample chamber (27a) and guard sample chamber (27b). Borehole fluids are preferentially drawn into the guard zone so that the probe zone then recovers formation fluid from beyond the mucake (5) substantially free of borehole fluids and drilling fluids. Separation of the guard zone from the probe zone may be accomplished by elastomeric guard rings (15), inflatable packers or coaxial/snorkel tubing. The test tool device having a probe (17), pad (13), clamps (10), fluid ID sensors (19a, 19b) and pumps (21a, 21b) is adaptable for use either on a wireline (3) or in an early evaluation system on a drillstring.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

FOCUSED FORMATION FLUID SAMPLING PROBE

FIELD OF THE INVENTION

The invention relates generally to formation fluid testing and collection apparatus and more particularly to a formation tester that reduces the contamination caused by borehole fluids in recovered formation fluids.

BACKGROUND OF THE INVENTION

In the oil and gas industry, formation testing tools have been used for monitoring formation pressures along a wellbore, obtaining formation fluid samples from the wellbore and predicting performance of reservoirs around the wellbore. Such formation testing tools typically contain an elongated body having an elastomeric packer that is sealingly urged against the zone of interest in the wellbore to collect formation fluid samples in storage chambers placed in the tool.

During drilling of a wellbore, a drilling fluid ("mud") is used to facilitate the drilling process and to maintain a pressure in the wellbore greater than the fluid pressure in the formations surrounding the wellbore. This is particularly important when drilling into formations where the pressure is abnormally high: if the fluid pressure in the borehole drops below the formation pressure, there is a risk of blowout of the well. As a result of this pressure difference, the drilling fluid penetrates into or invades the formations for varying radial depths (referred to generally as invaded zones) depending upon the types of formation and drilling fluid used. The formation testing tools retrieve formation fluids from the desired formations or zones of interest, test the retrieved fluids to ensure that the retrieved fluid is substantially free of mud filtrates, and collect such fluids in one or more chambers associated with the tool. The collected fluids are brought to the surface and analyzed to determine properties of such fluids and to determine the condition of the zones or formations from where such fluids have been collected.

One feature that all such testers have in common is a fluid sampling probe. This may consist of a durable rubber pad that is mechanically pressed against the rock formation adjacent the borehole, the pad being pressed hard enough to form a hydraulic seal. Through the pad is extended one end of a metal tube that also makes contact with the formation. This tube ("probe") is connected to a sample chamber that, in turn, is connected to a pump that operates to lower the pressure at the attached probe. When the pressure in the probe is lowered below the pressure of the formation fluids, the formation fluids are drawn through the probe into the well bore to flush the invaded fluids prior to sampling. In some prior art devices, a fluid

identification sensor determines when the fluid from the probe consists substantially of formation fluids; then a system of valves, tubes, sample chambers, and pumps makes it possible to recover one or more fluid samples that can be retrieved and analyzed when the sampling device is recovered from the borehole.

It is critical that only uncontaminated fluids are collected, in the same condition in which they exist in the formations. Commonly, the retrieved fluids are found to be contaminated by drilling fluids. This may happen as a result of a poor seal between the sampling pad and the borehole wall, allowing borehole fluid to seep into the probe. The mudcake formed by the drilling fluids may allow some mud filtrate to continue to invade and seep around the pad. Even when there is an effective seal, borehole fluid (or some components of the borehole fluid) may "invade" the formation, particularly if it is a porous formation, and be drawn into the sampling probe along with connate formation fluids.

In prior art operations, the pressure in the probe, and their connecting hydraulics flow line is lowered below the pressure of the fluid in the formation, drawing fluid from the formation into the probe, through the hydraulic flow line to the well bore. A fluid identification sensor may be installed in the hydraulic flow line, the fluid identification sensor producing a signal indicative of the composition of the fluid passing through it. When the fluid identification sensor determines that the fluid being pumped is primarily formation fluid, a sample chamber valve is opened and the sample chamber is filled.

Additional problems arise in Drilling Early Evaluation Systems (EES) where fluid sampling is carried out very shortly after drilling the formation with a bit. Inflatable packers or pads cannot be used in such a system because they are easily damaged in the drilling environment. In addition, when the packers are extended to isolate the zone of interest, they completely fill the annulus between the drilling equipment and the wellbore and prevent circulation during testing. Additionally, when an EES is used, there may be little or no mud cake formation prior to the test. A mud cake helps in sealing the formation from well bore fluids whereas in the absence of a mudcake, fluid leakage can be a serious problem. Pads are not adequate to provide a seal in the absence of a mudcake.

There is a need for an invention that reduces the leakage of borehole fluid into the sampling probe by isolating the probe from the borehole fluid. Such an invention should also reduce the amount of borehole fluid contaminating the connate fluid being withdrawn from the formation by the probe. Additionally, the invention should be able to sample formation fluids even when the mudcake is thin or non existent. There is a need for an invention that reduces

the time spent on sampling and flushing of contaminated samples. The present invention satisfies this need.

SUMMARY OF THE INVENTION

One embodiment of the invention, suitable for use on a wireline, employs a hydraulic guard ring surrounding the probe tube to isolate the probe from the borehole fluid. The guard ring is provided with its own flow line and sample chamber, separate from the flow line and the sample chamber of the probe. By maintaining the pressure in the guard ring at or slightly below the pressure in the probe tube, most of the fluid drawn into the probe will be connate formation fluid. The same result is also obtained by using inflatable packer elements to create a guard ring above and below the sampling section. An alternate embodiment of the invention useful in Drilling Early Evaluation Systems uses two sets of seal elements are used to obtain an uncontaminated fluid sample. Two thin seals, such as the wall of a small pipe are employed to isolate two areas of the formation at the borehole wall: one between the inner and outer seals and the second in the center of the inner seal.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a simplified schematic illustration of an embodiment of the present invention;

Figure. 2 shows a detail of the arrangement of the guard ring in the embodiment illustrated in Figure 1;

Figure 3 is a simplified schematic illustration of an alternate embodiment of the present invention using inflatable packers on a wireline;

Figure 4 is a simplified schematic illustration of an embodiment of the invention for use in a drilling Early Evaluation System using snorkel tubes;

Figure 5 illustrates some possible arrangements of the tubes in the invention of Figure 4;

Figure 6 is a simplified schematic illustration of the invention for use in a drilling Early Evaluation System using inflatable packers on a drill pipe;

Figure 7 shows the simulation of fluid flow in a prior art device;

Figure 8 shows a simulation of the direction of fluid flow in the vicinity of a fluid sampling pad.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is best understood by reference to Figures 1-3. Figure 1 is a schematic illustration of the preferred embodiment of the present invention. A portion of a borehole 1 is shown in a subterranean formation 7. The borehole wall is covered by a mudcake

5. The formation tester body 9 is connected to a wireline 3 leading from a rig at the surface (not shown). Alternatively, the formation tester body may be carried on a drillstring. The details of the method of connection of the tester body to a wireline or drillstring would be familiar to those versed in the art.

The formation tester body is provided with a mechanism, denoted by 10, to clamp the tester body at a fixed position in the borehole. This clamping mechanism is at the same depth as a probe and guard ring arrangement, details of which are seen in Figure 2.

By means of the clamping mechanism, 10, a fluid sampling pad, 13, is mechanically pressed against the borehole wall. A probe tube, 17, is extended from the center of the pad, through the mud cake, 5, and pressed into contact with the formation. The probe is connected by a hydraulic flow line, 23a, to a probe sample chamber, 27a.

The probe is surrounded by a guard ring, 15. The guard ring is a hydraulic tube, formed into a loop, that encircles the probe. The guard ring has suitable openings along its length, the openings being in contact with the formation. The guard ring is connected by its own hydraulic flow line, 23b, to a guard sample chamber, 27b. Because the flow line 23a of the probe, 17, and flow line 23b of the guard ring, 15, are separate, the fluid flowing into the guard ring does not mix with the fluid flowing into the probe. The guard ring isolates the flow into the probe from the borehole beyond the pad 13. Thus three zones are defined in the borehole: a first zone consisting of the borehole outside the pad 13, a second zone (the guard zone) consisting of the guard ring 15 and a third zone (probe zone) consisting of the probe 17. The probe zone is isolated from the first zone by the guard zone.

The hydraulic flow lines 23a and 23b are each provided with pressure transducers 11a and 11b. The pressure maintained in the guard flowline is the same as, or slightly less than, the pressure in the probe flowline. With the configuration of the pad and the guard ring, borehole fluid that flows around the edges of the pad is preferentially drawn into the guard ring, 15, and diverted from entry into the probe, 17.

The flow lines 23a and 23b are provided with pumps 21a and 21b. These pumps are operated long enough to substantially deplete the invaded zone in the vicinity of the pad and to establish an equilibrium condition in which the fluid flowing into the probe is substantially free of contaminating borehole filtrate.

The flow lines 23a and 23b are also provided with fluid identification sensors, 19a and 19b. This makes it possible to compare the composition of the fluid in the probe flowline 23a with the fluid in the guard flowline 23b. During initial phases of operation of the invention, the

composition of the two fluid samples will be the same; typically, both will be contaminated by the borehole fluid. These initial samples are discarded. As sampling proceeds, if the borehole fluid continues to flow from the borehole towards the probe, the contaminated fluid is preferentially drawn into the guard ring. Pumps 21a and 21b discharge the sampled fluid into the borehole. At some time, an equilibrium condition is reached in which contaminated fluid is drawn into the guard ring and uncontaminated fluid is drawn into the probe. The fluid identification sensors 19a and 19b are used to determine when this equilibrium condition has been reached. At this point, the fluid in the probe flowline is free or nearly free of contamination by borehole fluids. Valve 25a is opened, allowing the fluid in the probe flowline 23a to be collected in the probe sample chamber 27a. Similarly, by opening valve 25b, the fluid in the guard flowline is collected in the guard sample chamber 27b. The ability to pump from the guard ring into the guard sample chamber is one of the novel features of the invention: this results in an increased rate of flow from the formation into the probe and thereby improves the shielding effect of the guard ring. Alternatively, the fluid gathered in the guard ring can be pumped to the borehole while the fluid in the probe line is directed to the probe sample chamber 27a. Sensors that identify the composition of fluid in a flowline would be familiar to those knowledgeable in the art.

Figure 3 shows an alternate embodiment of the invention. A portion of a borehole 101 is shown in a subterranean formation 107. The borehole wall is covered by a mudcake 105. The formation tester body 109 is connected to a wireline 103 leading from a rig at the surface (not shown). The details of the method of connection of the tester body to the wireline would be familiar to those versed in the art.

The formation tester body is provided with inflatable flow packers 112 and 112′ and inflatable guard packers 110 and 110′. When the formation tester is at the depth at which formation fluids are to be sampled, the inflatable packers 110, 110′, 112 and 112′ are inflated to form a tight seal with the borehole wall and mudcake 105. The mechanism for activating the packers would be familiar to those versed in the art.

A hydraulic flow line (probe flowline) 123a is connected to an opening 114 in the tester located between the flow packers 112 and 112′ and to a probe sample chamber 127a. This serves to sample formation fluid that flows into the borehole between the two flow packers. A second hydraulic flow line (guard flowline) 123b is connected to openings 116 and 116' in the tester located between the guard packer 110 and the flow packer 112 and between the guard packer 110' and flow packer 112′ respectively. The guard flowline is connected to a guard

sample chamber 127b. Thus three zones are defined in the borehole: a first zone consisting of the borehole above the packer 110 and below the packer 110', a second zone (the guard zone) consisting of the region between the packers 110 and 112 and between the packer 110' and 112' ; and a third zone (probe zone) consisting of the zone between the packers 112 and 112'. The probe zone is isolated from the first zone by the guard zone.

The hydraulic flow lines 123a and 123b are each provided with pressure transducers 111a and 111b. The pressure maintained between each of the flow packers and the adjacent guard packer is the same as, or slightly less than, the pressure between the two flow packers. With the configuration of the guard and flow packers, borehole fluid that flows around the edges of the guard packers is preferentially drawn into the guard flowline 123b, and diverted from entry into the probe flowline 123a.

The flow lines 123a and 123b are provided with pumps 121a and 121b. These pumps are operated long enough to substantially deplete the invaded zone in the vicinity of the tool and to establish an equilibrium condition in which the fluid flowing into the probe flowline is substantially free of contaminating borehole filtrate.

The flow lines 123a and 123b are also provided with fluid identification sensors, 119a and 119b. This makes it possible to compare the composition of the fluid in the probe flowline 123a with the fluid in the guard flowline 123b. During initial phases of operation of the invention, the composition of the two fluid samples will be the same; typically, both will be contaminated by the borehole fluid. These initial samples are discarded. As sampling proceeds, if the borehole fluid continues to flow from the borehole towards the opening 114, the contaminated fluid is preferentially drawn into the openings 116 and 116'. Pumps 121a and 121b discharge the sampled fluid into the borehole. At some time, an equilibrium condition is reached in which contaminated fluid is drawn into the guard flowline and uncontaminated fluid is drawn into the probe flowline. The fluid identification sensors 119a and 119b are used to determine when this equilibrium condition has been reached. At this point, the fluid in the probe flowline is free or nearly free of contamination by borehole fluids. Valve 125a is opened, allowing the fluid in the probe flowline 123a to be collected in the probe sample chamber 127a. Similarly, by opening valve 125b, the fluid in the guard flowline is collected in the guard sample chamber 127b. The ability to pump from the guard ring into the guard sample chamber is one of the novel features of the invention: this results in an increased rate of flow from the formation into the probe and thereby improves the shielding effect of the guard ring.

Figure 4 shows an alternate embodiment of the invention suitable for use in a drilling early evaluation system (EES). The borehole wall 205 in a formation 207 is indicated. The EES tool 209 is inside the borehole and attached to the drilling means (not shown). For simplicity of illustration, only one side of the EES tool is shown. Contact with the formation is accomplished by means of an outer snorkel tube 215 and an inner snorkel tube 217. The two tubes are independently movable, the inner snorkel tube 217 having the capability of penetrating deeper into the formation. Means for operating snorkel tubes of this kind would be familiar to those knowledgeable in the art.

The inner snorkel tube 217 is connected to probe flowline 223a while the region between the inner snorkel tube 217 and the outer snorkel tube 215 defines a guard zone that is connected to the guard flowline 223b. Flowlines 223a and 223b are provided with pumps and sample chambers (not shown). The inner snorkel tube 217 defines a probe zone that is isolated by the outer snorkel tube 215 from the portion of the borehole outside the outer snorkel tube. These pumps are operated long enough to substantially deplete the invaded zone in the vicinity of the outer snorkel tube 215 and to establish an equilibrium condition in which the fluid flowing into the inner snorkel tube is substantially free of contaminating borehole filtrate. When the equilibrium condition is reached, contaminated fluid is drawn into the guard zone and uncontaminated fluid is drawn into the inner snorkel tube. At this time, sampling is started with the pumps continuing to operate for the duration of the sampling. As sampling proceeds, the borehole fluid continues to flow from the borehole towards the probe, while the contaminated fluid is preferentially drawn into the outer snorkel tube. Pumps (not shown) discharge the contaminated fluid into the borehole. The fluid from the inner snorkel tube is retrieved to provide a sample of the formation fluid.

Figures 5a-5c show alternative arrangements of the snorkel tube. In Figure 5a, the inner snorkel tube 241 and the outer snorkel tube 243 are shown as concentric cylinders. In Figure 5b, the annular region between the inner snorkel tube 245 and the outer snorkel tube 247 is segmented by means of a plurality of dividers 249. Figure 5c shows an arrangement in which the guard zone is defined by a plurality of tubes 259 interposed between the inner snorkel tube 255 and the outer snorkel tube 257. In any of these configurations, a wire mesh or a gravel pack may also be used to avoid damage to the formation.

Figure 6 shows an alternative EES tool that uses short packers instead of the snorkel tubes. The packers may be inflatable or may be expandable metal packers. A portion of a borehole 301, is shown in a subterranean formation, 307. The borehole wall is shown at 305.

The formation tester body 309, is connected to a drilling apparatus. The EES tool is provided with short flow packers 312 and 312′ and guard packers 310 and 310′. The zone between the flow packers 312 and 312′ defines the probe zone while the zone between the flow packers and the guard packers 310 and 310′ defines the guard zone. When the formation tester is at the depth at which formation fluids are to be sampled, the inflatable packers 310, 310′, 312 and 312′ are inflated to form a tight seal with the borehole wall 305. The mechanism for activating the packers would be familiar to those versed in the art. Thus three zones are defined in the borehole: a first zone consisting of the borehole above the packer 310 and below the packer 310', a second zone (the guard zone) consisting of the region between the packers 310 and 312 and between the packer 310' and 312' ; and a third zone (probe zone) consisting of the zone between the packers 312 and 312'. The probe zone is isolated from the first zone by the guard zone.

A hydraulic flow line (probe flowline), 323, is connected to an opening, 314, in the tester located in the probe zone and to a pump (not shown). This serves to sample formation fluid that flows into the borehole between the two flow packers. A second hydraulic flow line (guard flowline), 323b, is connected to openings 316 and 316' in the tester located between the guard zone. The pumps are operated long enough to substantially deplete the invaded zone in the vicinity of the pad and to establish an equilibrium condition in which the fluid flowing into the inner snorkel tube is substantially free of contaminating borehole filtrate. As sampling proceeds, if the borehole fluid continues to flow from the borehole towards the probe, the contaminated fluid is preferentially drawn into the guard ring. Pumps (not shown) discharge the sampled fluid into the borehole. At some time, an equilibrium condition is reached in which contaminated fluid is drawn into the guard zone and uncontaminated fluid is drawn into the inner snorkel tube. This fluid is retrieved to provide a sample of the formation fluid. The pumps continue to operate during the process of retrieval of the formation fluid from the inner snorkel tube.

The walls of the packers need only be thick enough to provide the necessary structural arrangement wherein the flow into the inner tube is isolated from the flow outside; this means that problems encountered in prior art where, in the absence of a mudcake, leakage occurs around the packers is circumvented.

EXAMPLES

The effectiveness of the focused type probe is demonstrated by the results of a finite element simulation shown in Figures 7 and 8. In both figures, one fourth of the pad area is

shown with the remaining portion cut away to see into the formation. Figure 7 is for the simulation of an unfocussed flow, i.e., a conventional probe according to prior art. In Figure 7, the direction labeled 421 is radial and into the formation, 425 follows the borehole wall vertically and 423 follows the borehole wall circumferentially. The center of the probe is at the intersection of 421, 423 and 425. The arrows in Figure 7 show the direction of fluid flow in the simulation. The zones labeled 427 and 427' show that borehole fluid is flowing into the probe and contaminating the fluid drawn into the probe. In addition, the zone labeled as 429 generally corresponds to borehole fluids that have invaded the formation and are flowing back into the probe.

Figure 8 is for the simulation of a focused flow, i.e., a probe according to the present invention. The direction labeled 431 is radial and into the formation, 435 follows the borehole wall vertically and 433 follows the borehole wall circumferentially. The center of the probe is at the intersection of 431, 433 and 435. The arrows in show the direction of fluid flow in the simulation. It can be seen in Figure 8 that in the zones corresponding to 427 and 427' in Figure 7, the flow direction is radial, i.e., the borehole fluid is not being drawn into the probe. Instead, the borehole fluid flows into the zone labeled as 437. This corresponds to the position of the guard ring, packer or snorkel tube.. Furthermore, in the zone corresponding to 429 in Figure 7, the flow direction is radial, indicating that the probe is effectively draining fluid from deeper into the formation with less contamination by invaded borehole fluids.

The foregoing description has been limited to specific embodiments of this invention. It will be apparent, however, that variations and modifications may be made to the disclosed embodiments, with the attainment of some or all of the advantages of the invention. Therefore, it is the object of the appended claims to cover all such variations and modifications as come within the true spirit and scope of the invention

CLAIMS

What is claimed is:

1. A formation tester tool for retrieving a formation fluid from a formation surrounding a wellbore having a drilling fluid, comprising:

(a) a first element adapted to retrieve the formation fluid from a first (probe) zone in the formation;

(b) an isolation device, said isolation device defining a second (guard) zone adjacent the probe zone; and

(c) a device for retrieving fluid from the guard zone in order to reduce the flow of the drilling fluid into the probe zone.

2. The formation tester tool of claim 1, wherein the first element is a probe adapted to contact said the formation.

3. The formation tester tool of claim 1 wherein the isolation device is a guard ring.

4. The formation tester tool of claim 3 wherein the device for retrieving fluid from the guard zone is a guard flow line connected to the guard zone.

5. The formation tester tool of claim 4 further comprising a probe flow line connected to the probe zone.

6. The formation tester tool of claim 5, further comprising a first control device for controlling fluid flow into the probe flow line and a second control device for controlling fluid flow into the guard flow line.

7. The formation tester tool of claim 6, wherein the first control device maintains a first pressure in the probe flow line and the second control device maintains a second pressure in the guard flow line, the first pressure being greater than or equal to the second pressure.

8. The formation tester tool of claim 7, further comprising a first fluid analysis device in the probe flow line and a second fluid analysis device in the guard flow line.

9. The formation tester tool of claim 8 further comprising a probe fluid sample chamber connected to the probe flow line.

10. The formation tester tool of claim 9 wherein the formation tester tool is adapted to be used on a wireline.

11. The formation tester tool of claim 1 wherein the first element comprises a pair of probe packers adapted to engage the walls of the borehole defining the probe zone therebetween and the isolation device comprises a pair of guard packers disposed about the pair of probe packers,

said guard packers adapted to engage the walls of the borehole and define the guard zone between each of the probe packers and the adjacent guard packer.

12. The formation tester tool of claim 11 further comprising a probe flow line connected to the probe zone.

13. The formation tester tool of claim 12 wherein the tool is adapted to be used on a wireline.

14. The formation tester tool of claim 12 wherein the tool is adapted to be used on a drillstring.

15. The formation tester tool of claim 13, further comprising a first control device for controlling fluid flow into the probe flow line and a second control device for controlling fluid flow into the second line.

16. The formation tester tool of claim 15, wherein the first control device maintains a first pressure in the probe flow line and the second control device maintains a second pressure in the guard flow line, the second pressure being less than or equal to the first pressure.

17. The formation tester tool of claim 16, further comprising a first fluid analysis device in the probe flow line.

18. The formation tester tool of claim 1, wherein the first element comprises an inner snorkel tube adapted to penetrate the formation and the isolation device comprises an outer snorkel tube adapted to penetrate the formation.

19. The formation tester tool of claim 18 wherein the tool is adapted to be used on a drillstring.

20. A method for retrieving a formation fluid from a formation surrounding a wellbore having a drilling fluid, comprising: conveying a formation tester into the wellbore, said formation tester defining a probe zone and a guard zone adjacent the formation; operating the formation tester to retrieve fluid from the guard zone and reducing the flow of the drilling fluid into the probe zone; and retrieving fluid from the probe zone.

21. The method of claim 20, further comprising: connecting a guard flow line to the guard zone; connecting a probe flow line to the probe zone.

22. The method of claim 21 further comprising lowering the pressure in the guard flow line to below the pressure of the probe flow line.

23. The method of claim 22 further comprising determining when the fluid in the probe flow line is substantially free of drilling fluids.

24. The method of claim 20, further comprising:

(a) expanding a pair of guard packers on the formation tester to engage the walls of the borehole; and

(b) expanding a pair of probe packers on the formation tester to engage the walls of the borehole and defining the probe zone therebetween. the probe packers being disposed between the guard packers and defining the guard zone between each of the probe packers and the adjacent guard packer.

25. The method of claim 24 further comprising operating the formation tester on a wireline.

26. The method of claim 24 further comprising operating the formation tester on a drillstring.

27. The method of claim 20 further comprising:

(a) activating an inner tube on the formation tester to penetrate the formation to define the probe zone, and

(b) activating an outer tube on the formation tester to penetrate the formation, to define the guard zone by the region between the first tube and the second tube.

28. A formation tester tool for retrieving a formation fluid from a formation surrounding a wellbore having a drilling fluid, comprising:

(a) a probe adapted to retrieve the formation fluid from a first (probe) zone in the formation;

(b) a guard ring, said guard ring defining a second (guard) zone adjacent the probe zone; and

(c) a device for retrieving fluid from the guard zone in order to reduce the flow of the drilling fluid into the probe zone. .

29. The formation tester tool of claim 28 further comprising a probe flow line connected to the probe zone.

30. The formation tester tool of claim 29 further comprising:

(a) a first control device for controlling fluid flow into the probe flow line; and

(b) a second control device for controlling fluid flow into the guard flow line; wherein the first control device maintains a first pressure in the probe flow line and the second control device maintains a second pressure in the guard flow line. the first pressure being greater than or equal to the second pressure.

31. A formation tester tool for retrieving a formation fluid from a formation surrounding a wellbore having a drilling fluid, comprising:

(a) a pair of probe packers adapted to engage the walls of the borehole defining a probe zone therebetween:

(b) a pair of guard packers adapted to engage the walls of the borehole, disposed about the pair of probe packers, defining a guard zone between each of the probe packers and the adjacent guard packer; and

(c) a device for retrieving fluid from the guard zone in order to reduce the flow of the drilling fluid into the probe zone.

32. The formation tester tool of claim 31 further comprising a probe flow line connected to the probe zone.

33. The formation tester tool of claim 32 wherein the tool is adapted to be used on a wireline.

34. The formation tester tool of claim 31 wherein the tool is adapted to be used on a drillstring.

35. The formation tester tool of claim 33 further comprising:

(a) a first control device for controlling fluid flow into the probe flow line; and

(b) a second control device for controlling fluid flow into the guard flow line; wherein the first control device maintains a first pressure in the probe flow line and the second control device maintains a second pressure in the guard flow line, the first pressure being greater than or equal to the second pressure.

36. A formation tester tool for retrieving a formation fluid from a formation surrounding a wellbore having a drilling fluid, comprising:

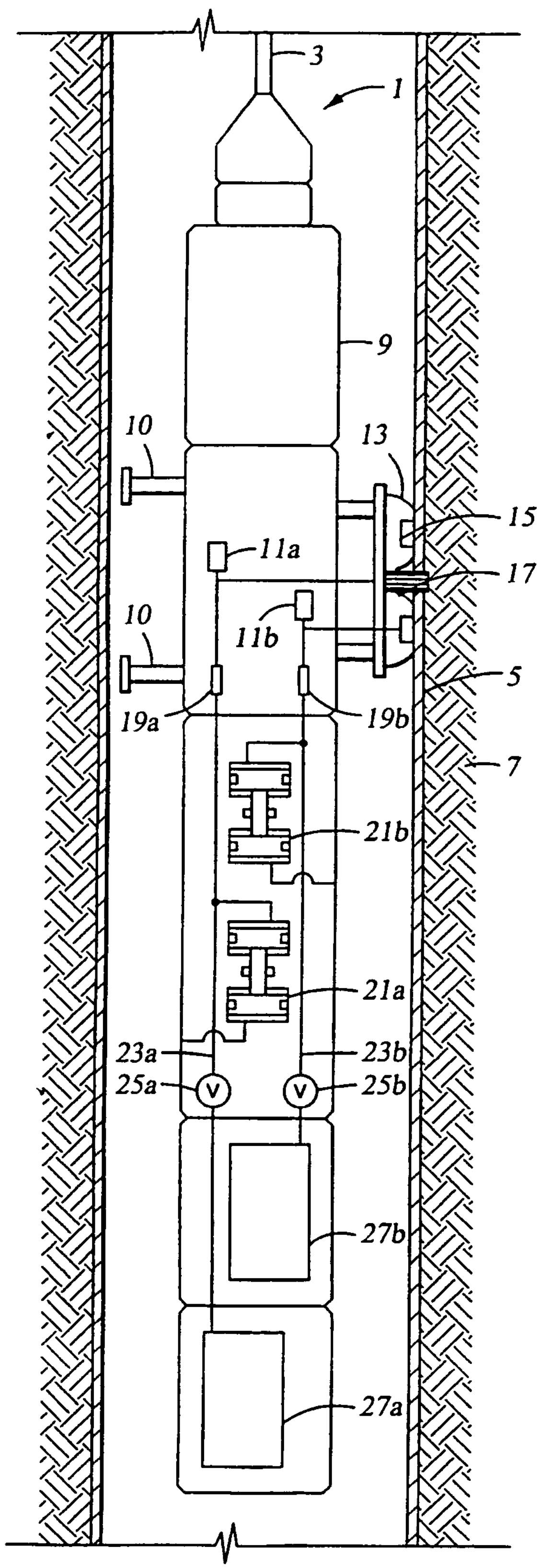
(a) an inner tube adapted to penetrate the formation, said inner tube defining a probe zone;

(b) an outer tube adapted to penetrate the formation, the outer tube defining a guard zone as the region between the first tube and the second tube; and

(c) a device for retrieving fluid from the guard zone in order to reduce the flow of the drilling fluid into the probe zone.

37. The formation tester tool of claim 36 wherein the tool is adapted to be used on a drillstring.

38. The formation tester tool of claim 37 further comprising a probe fluid line connected to the probe zone.


3
1
9
10
13
15
11a
17
11b
10
5
19a
19b
7
21b
21a
23a
23b
25a
25b
27b
27a

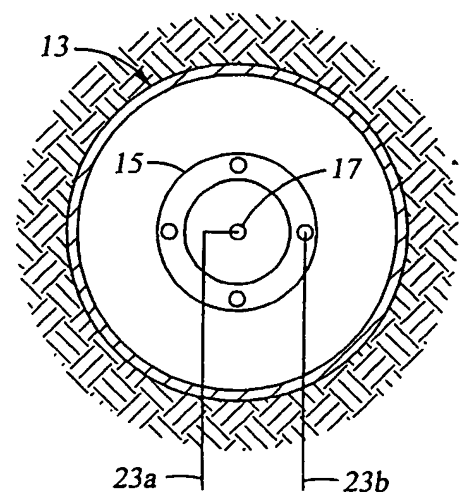

13
15
17
23a
23b

Fig. 2

Fig. 1

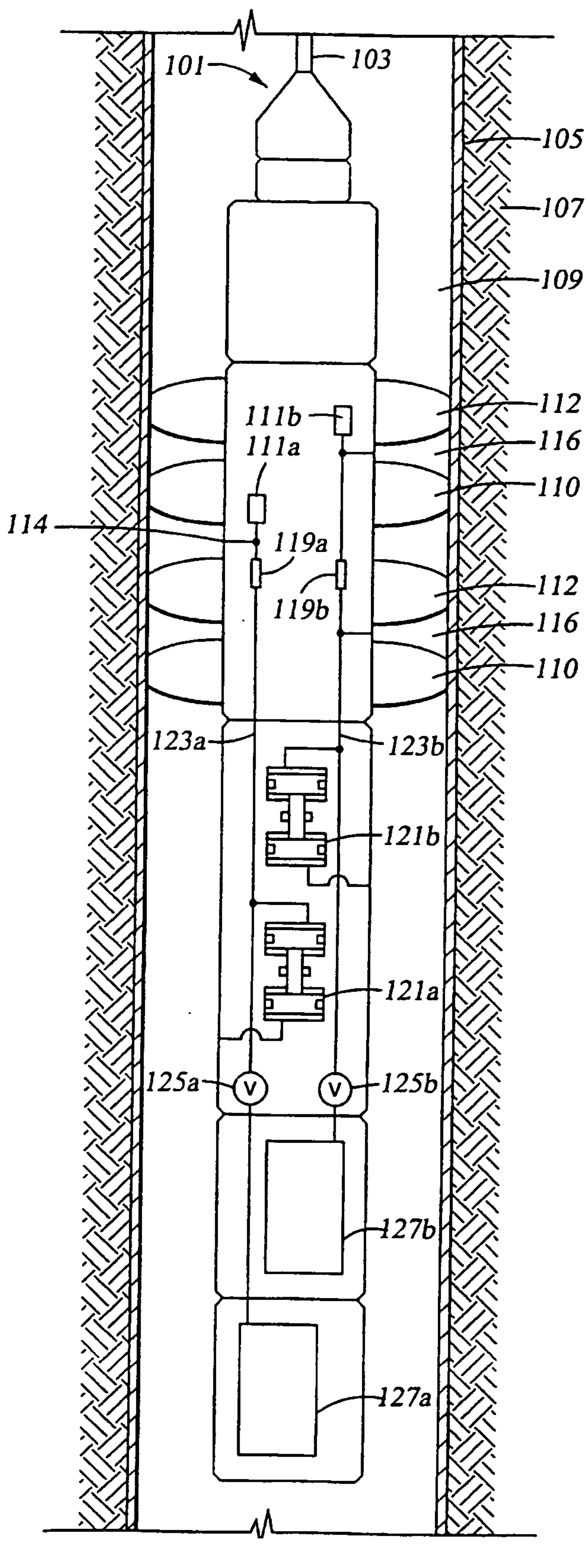

101
103
105
107
109
112
116
110
111b
111a
114
119a
119b
112
116
110
123a
123b
121b
121a
125a
125b
V
V
127b
127a

Fig. 3

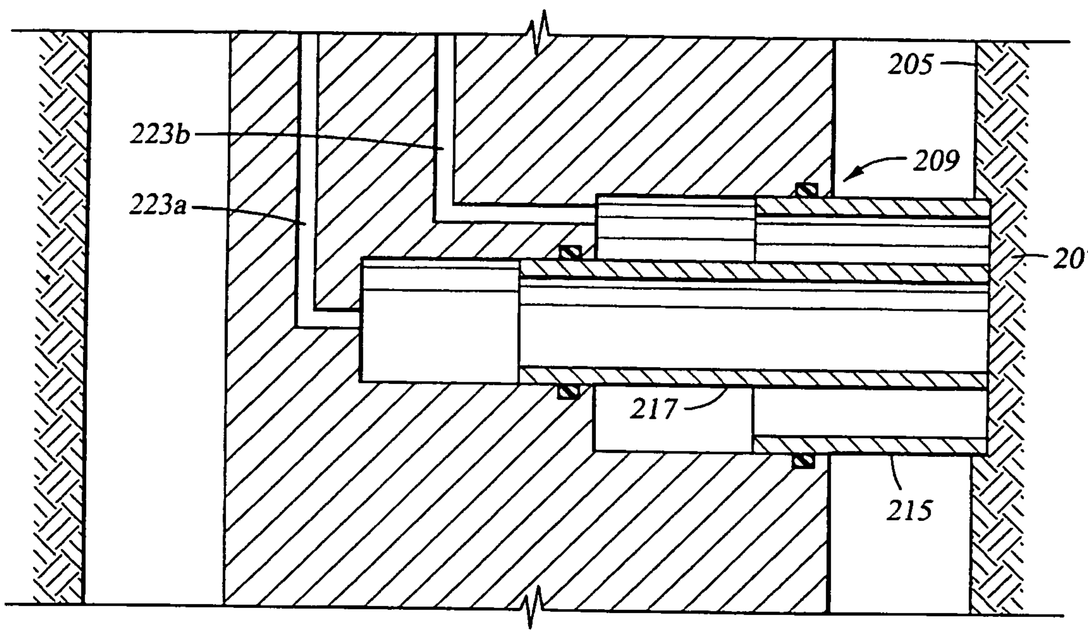


Fig. 4

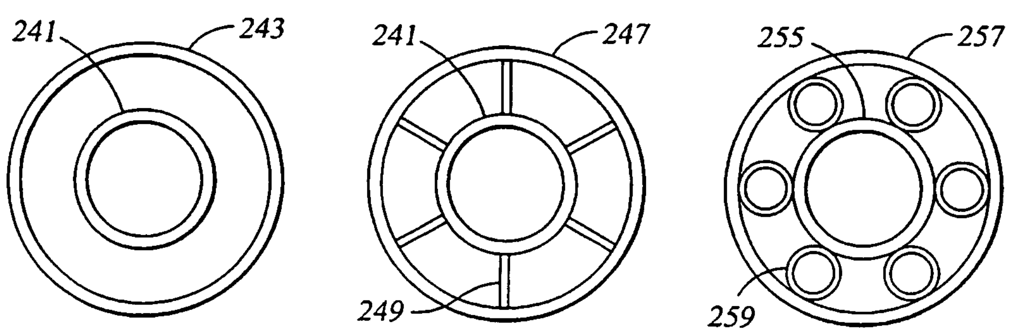


Fig. 5A Fig. 5B Fig. 5C

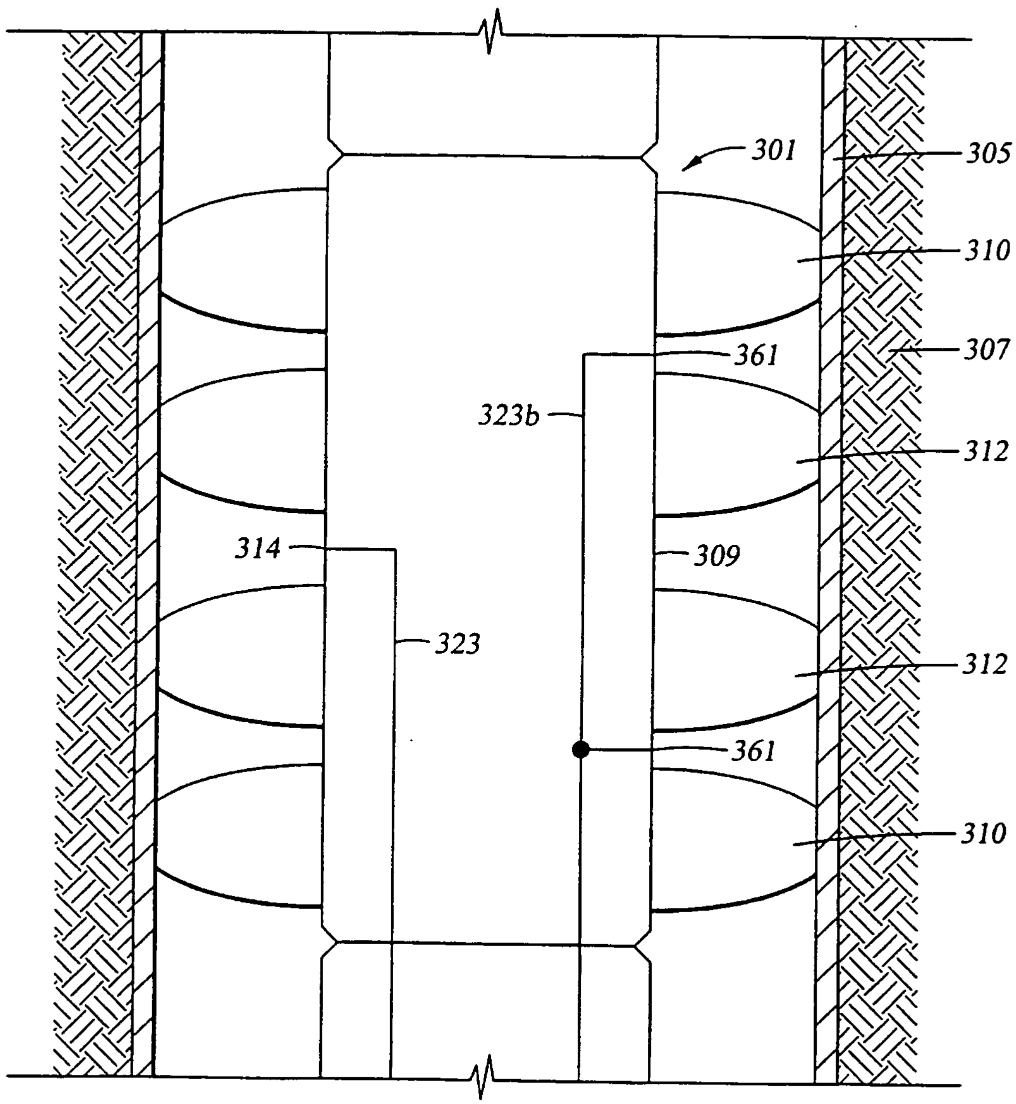


Fig. 6

Fig. 7

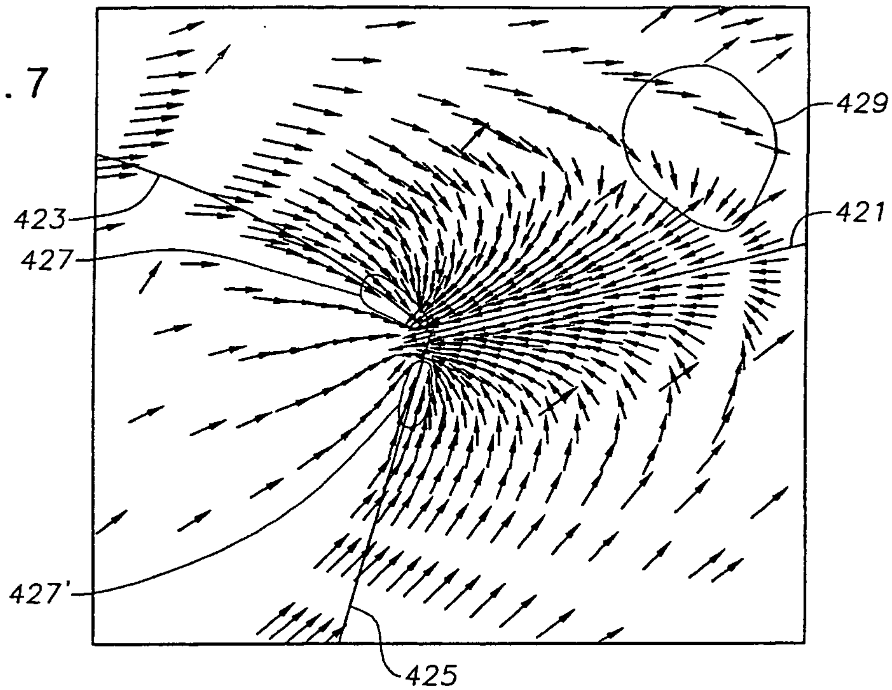
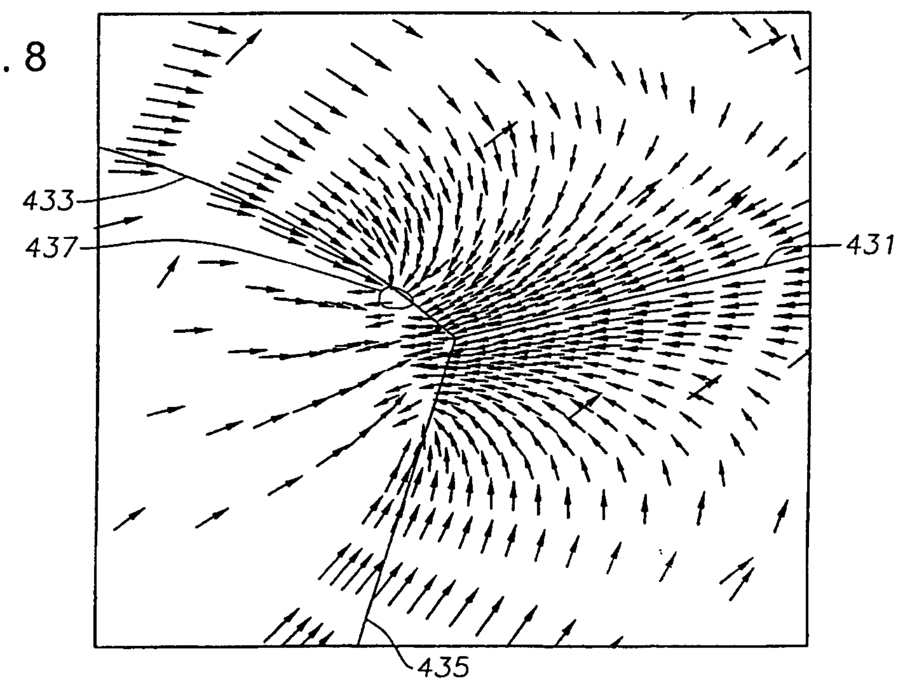


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01951

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : GO1V 03/18; E21B 49/08, 47/00, 47/10, 49/00
US CL : 073/152.23, 152.46, 152.28, 152.36, 152.26; 166/254.20, 250.17; 175/59
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 073/152.23, 152.46, 152.28, 152.36, 152.26, 152.21, 152.31, 152.55, 152.02, 152.03; 166/254.20, 250.17, 264.00; 175/59

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,392,376 A (LAGUS et al.) 12 July 1983 (12.07.83), Col. 5, line 27 - Col. 6, line 61, Col. 2, line 27 - Col. 3, line 32, Col. 3, line 37 - Col. 4, line 31 and Col. 1, lines 10-47 along with Figure 1.	1, 3-6, 11-14, 24-26, 20-21 28-29 and 30-34
X	US 5,230,244 A (GILBERT) 27 July 1993 (27.07.93), Col. 3, line 2 - Col. 4, line 50 along with Figures 1 & 2.	2, 18-19, 27 and 36-38
Y	US 5,337,838 A (SORENSEN) 16 August 1994 (16.08.94), Col. 1, lines 8-14, Col. 2, lines 20-65, Col. 5, lines 6-51, Col. 6, lines 35-57 and Col. 7, lines 10-53 along with Figure 1.	1-6, 11-14, 20-21, 24, 26, 28-29, 30-32 & 34

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 APRIL 2000	27 JUN 2000

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	DAVID JOHN WIGGINS
Facsimile No. (703) 305-3230	Telephone No. (703) 305-4884

Form PCT/ISA/210 (second sheet) (July 1998)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01951

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,323,361 A (LEBOURG) 06 June 1967 (06.06.67), Col. 1, lines 44-65, Col. 2, lines 29-69, Col. 5, line 6 - Col. 6, line 59 and Col. 8, lines 3-35 plus bypass passageway 20 in Figure 2.	1, 3-6, 11-14, 20-21, 24-26, 28-29 and 31-34
A	US 5,831,156 A (MULLINS) 03 November 1998 (03.11.98), see entire document.	1-38
A	US 3,762,219 A (JESSUP) 02 October 1973 (02.10.73), see entire text.	1-38
A	US 4,635,717 A (JAGELER) 13 January 1987 (13.01.87), see entire document.	1-38
A	US 3,969,937 A (BARRINGTON et al.) 20 July 1976 (20.07.76), see entire document.	1-17, 20-26 and 28-35
		1-38
A	US 3,530,711 A (TOCANNE) 29 September 1970 (29.09.70), see entire document.	1, 3, 11, 13, 20-21, and 31-33
A	US 2,503,557 A (MCKINLEY) 11 April 1950 (11.04.50), see entire document.	1-6, 11-14, 20-21, 24-26, 28-29 and 31-34
A	US 2,189,919 A (MOORE) 13 February 1940 (13.02.40), see entire document.	1-6, 11-14, 20-21, 24-26, 28-29 and 31-34

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01951

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2,623,594 A (SEWELL) 30 December 1952 (30.12.52), see entire document.	1-6, 11-14, 20-21, 18-19, 24-26, 27 28-29, 31-34 and 36-38
A	US 4,416,152 A (WILSON) 22 November 1983 (22.11.83), see entire document.	18, 19, 27 and 36-38
A	US 2,747,401 A (DOLL) 29 May 1956 (29.05.56), see entire document.	1-6, 20-21, 28-29, 18-19, 27 and 36-38
A	US 4,860,581 A (ZIMMERMAN et al.) 29 August 1989 (29.08.89), see entire document.	1-6, 20-21, 28-29, 18-19, 27 and 36-38
A	US 3,611,799 A (DAVIS) 12 October 1971 (12.10.71), see entire document.	1-38

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01951

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01951

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

USPTO APS STN/CAS search terms: formation fluid, sampling, retrieving or producing; pump; borehole or wellbore or oilwell; guard, isolate or shielding; fluid, oil, water, gas or liquid; probe, sensor, detector or gauge; mudcake, wall or casing; pressure; flow paths or lines; drilling or borehole fluids, wireline, drill string or drillpipe; guard ring, torus, annulus, disc circle, band or donut; packer; snorkel; concentric or coaxial tube; inflatable bladder or balloon; chamber;

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains claims directed to more than one group or embodiment of the disclosed invention. These groups are deemed to lack Unity of Invention because they are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all the additional inventions to be searched, the appropriate additional search fees must be paid. The distinct groups of inventions are as follows:

Group I, claims 3-10 and 28-30 corresponding to Figure 2: drawn to formation tester tool and retrieval of formation fluid with an isolation device for isolating the probe from drilling fluid during formation measurements & fluid retrieval, wherein the tool is adapted for connection via wireline and isolation is achieved by use of guard ring(s) for making a guard zone(s).
Group II, claims 11-13, 15-17, 25, 31-33 and 35 corresponding to Figure 3: drawn to formation tester tool and retrieval of formation fluid with an isolation device for isolating the probe from drilling fluid during formation measurements & fluid retrieval, wherein the tool is adapted for connection via wireline and isolation is achieved by use of inflatable packer(s) for making a guard zone.
Group III, claims 18, 27 and 36 corresponding to Figure 4: drawn to formation tester tool and retrieval of formation fluid with an isolation device for isolating the probe from drilling fluid during formation measurements & fluid retrieval, wherein the tool is adapted for connection via wireline and isolation is achieved by use of coaxial tubes or snorkel tubes for making a guard zone.
Group IV, claims 3-9 and 28-30 corresponding to Figure 2: drawn to formation tester tool and retrieval of formation fluid with an isolation device for isolating the probe from drilling fluid during formation measurements & fluid retrieval, wherein the tool is adapted for connection via drill string stem or drill string pipe and isolation is achicved by use of guard ring(s) for making a guard zone(s).
Group V, claims 14, 26 and 34 corresponding to Figure 3: drawn to formation tester tool and retrieval of formation fluid with an isolation device for isolating the probe from drilling fluid during formation measurements & fluid retrieval, wherein the tool is adapted for connection via drill string stem or drill string pipe and isolation is achieved by use of inflatable packer(s) for making a guard zone.
Group VI, claims 19 and 37-38 corresponding to Figure 4: drawn to formation tester tool and retrieval of formation fluid with an isolation device for isolating the probe from drilling fluid during formation measurements & fluid retrieval, wherein the tool is adapted for connection via drill string stem or drill string pipe and isolation is achieved by use of coaxial tubes or snorkel tubes for making a guard zone.

And it considers that the International Application does not comply with the requirements of unity of invention (Rules 13.1, 13.2 and 13.3) for the reasons indicated below: (the groups listed above do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features according to the following reasons): The equipment employed to form a guard zone for isolating the probe during formation testing & formation fluid retrieval differs according to the 6 types of instant invention [whether or not a wireline/sonde connected tool or a drill string stem/drill string pipe connected tool is used, along with the further features of whether guard ring(s), inflatable packer(s) or coaxial/snorkel tube(s) are used on such wireline or drill string tool], which different apparatus involves a different search thru the compendium of all known patented and published prior art. Also, the methods and applications of testing a earth formation & retrieving fluids from such formation are different according to whether the formation tester tool is intended for mounting on a drill string stem/drill string pipe [i.e.- making measurements for formation evaluation during drilling of the well or borehole]; or is intended for mounting on a wireline [i.e.- logging for formation evaluation after the well or borehole is drilled].
In this instant PCT application No. PCT/US00/01951, any two of the Group I-VI invnetions to be compared against

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01951

each other are similar or opposite in terms of being either wireline or drill string pipe connected, while also being similar or opposite in terms of its chosen method for achieving isolation of the probe during a drilling or logging operation; e.g.- different family branching lines on a flow chart roots graph.